# BIOLOGICAL EVALUATION OF GYPSY MOTH

# AT

# RAYSTOWN LAKE, 2000-2001

Prepared by

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and

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## ABSTRACT

In the Fall of 2000, USDA Forest Service personnel conducted a gypsy moth egg mass survey at Raystown Lake to assess the potential for defoliation and the need for treatment in 2001. Current populations are sufficient to cause noticeable defoliation on 6,147 acres. Treatment is recommended in these areas in 2001.


## METHODS

The survey was conducted in 14 areas proposed for treatment by the U.S. Army Corps of Engineers (Figure 1). Within each area, gypsy moth survey plots were randomly selected based upon available host trees (oak species), size of sample area and uniformity between egg mass counts. At each sample point, a $1/40^{th}$ acre fixed radius plot was established. The plots consisted of a tally of all the new (2000) egg masses observed on the overstory trees, understory vegetation, ground litter and duff. The total number of egg masses observed for each plot was multiplied by 40 to determine the number of egg masses per acre.

Egg mass length was measured at most of the plots to determine the overall "health" of the existing population and as a measure of egg mass fecundity. The average egg mass length (measured in millimeters) and egg mass density (egg masses per acre) were used to estimate defoliation potential (Liebhold et al., 1993).

## RESULTS

The location of the survey plots are shown in Figures 2a-2d and the survey results are summarized in Tables 1-14. Overall egg mass densities ranged from 0-31,200 and averaged 1,880 egg masses per acre. Egg mass densities are high throughout the proposed treatment blocks at Susquehannock/Seven Points, Gate 35/Shy Beaver, Putts Camp and Peninsula Campground and averaged 5,941, 2,083, 4,480 and 2,536 egg masses per acre, respectively. Egg mass densities are fairly high in the proposed treatment blocks at Clapper's Ridge North, Tatman Run, Resort Area, Marker 18, the northern half of Upper Corners, the southern half of Terrace Mountain/Dam and the immediate area around Nancy's Campground and averaged 1,091, 1,367, 1,740, 960, 1,535, 1,207 and 1,587 egg masses per acre, respectively. Egg mass densities are fairly low in the proposed treatment blocks at Trough Creek, Terrace Mountain South and Clapper's Ridge South where densities average 165, 177 and 653 egg masses per acre, respectively. Egg mass lengths averaged 25 mm, but varied greatly in the proposed treatment blocks ranging from 10-42 mm.

## DISCUSSION

All the proposed treatment blocks are valued for recreational purposes, timber production, or wildlife habitat. Gypsy moth defoliation would have negative impacts on all three of these values.

The basic guidelines used to evaluate the risk of defoliation include: previous defoliation events; number of egg masses/acre; size and condition of the egg masses; available preferred food; and risk of larval blow-in following egg hatch. Potential defoliation is categorized as; light (1-30 percent); moderate (31-60 percent); and heavy (61-100 percent).

The survey results indicate that heavy defoliation is likely to occur on approximately 4,140 acres and moderate defoliation on 2,007 acres at Raystown Lake in 2001.

Figure 1. -- Proposed gypsy moth treatment blocks at Raystown Lake in 2001.

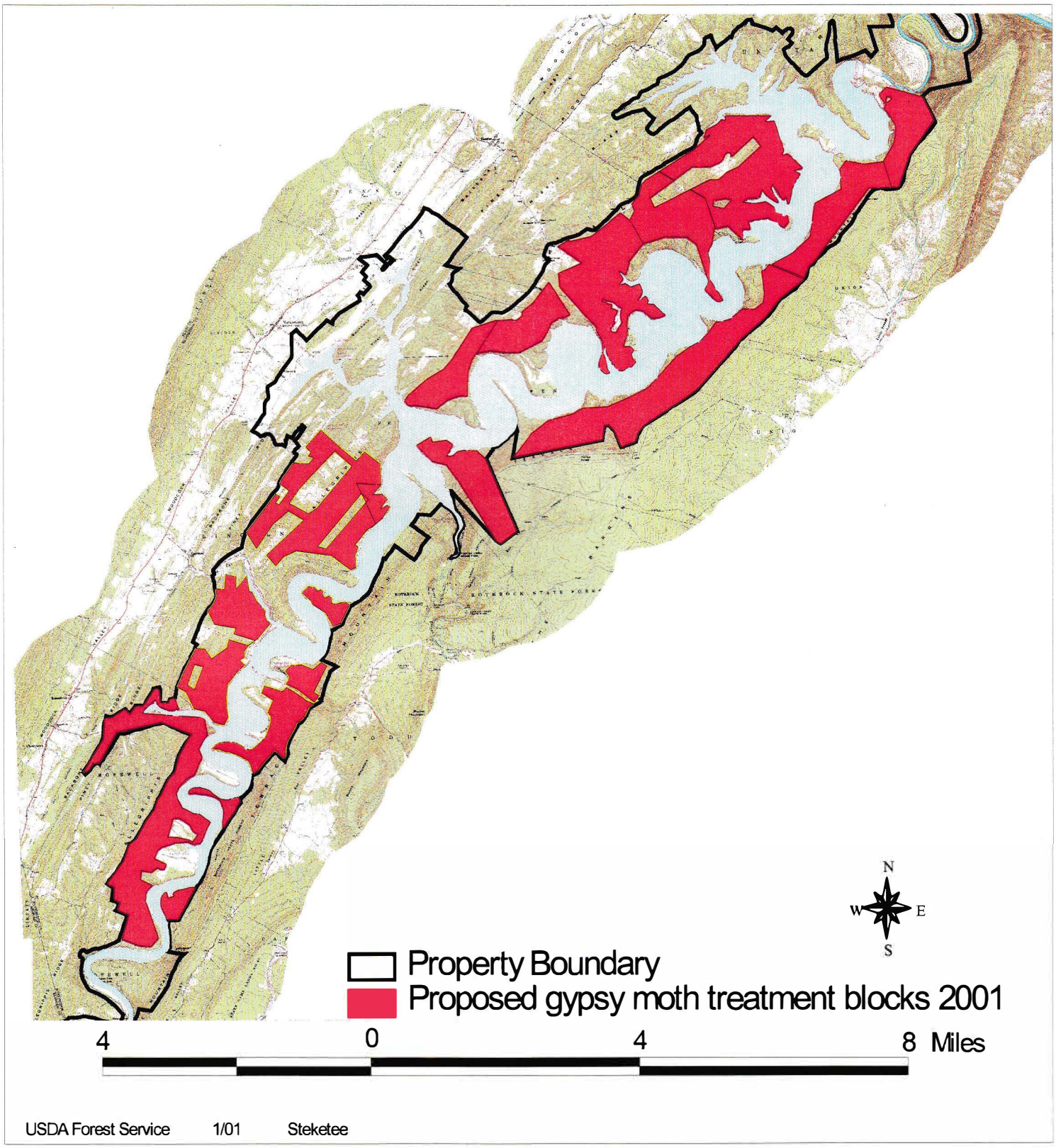
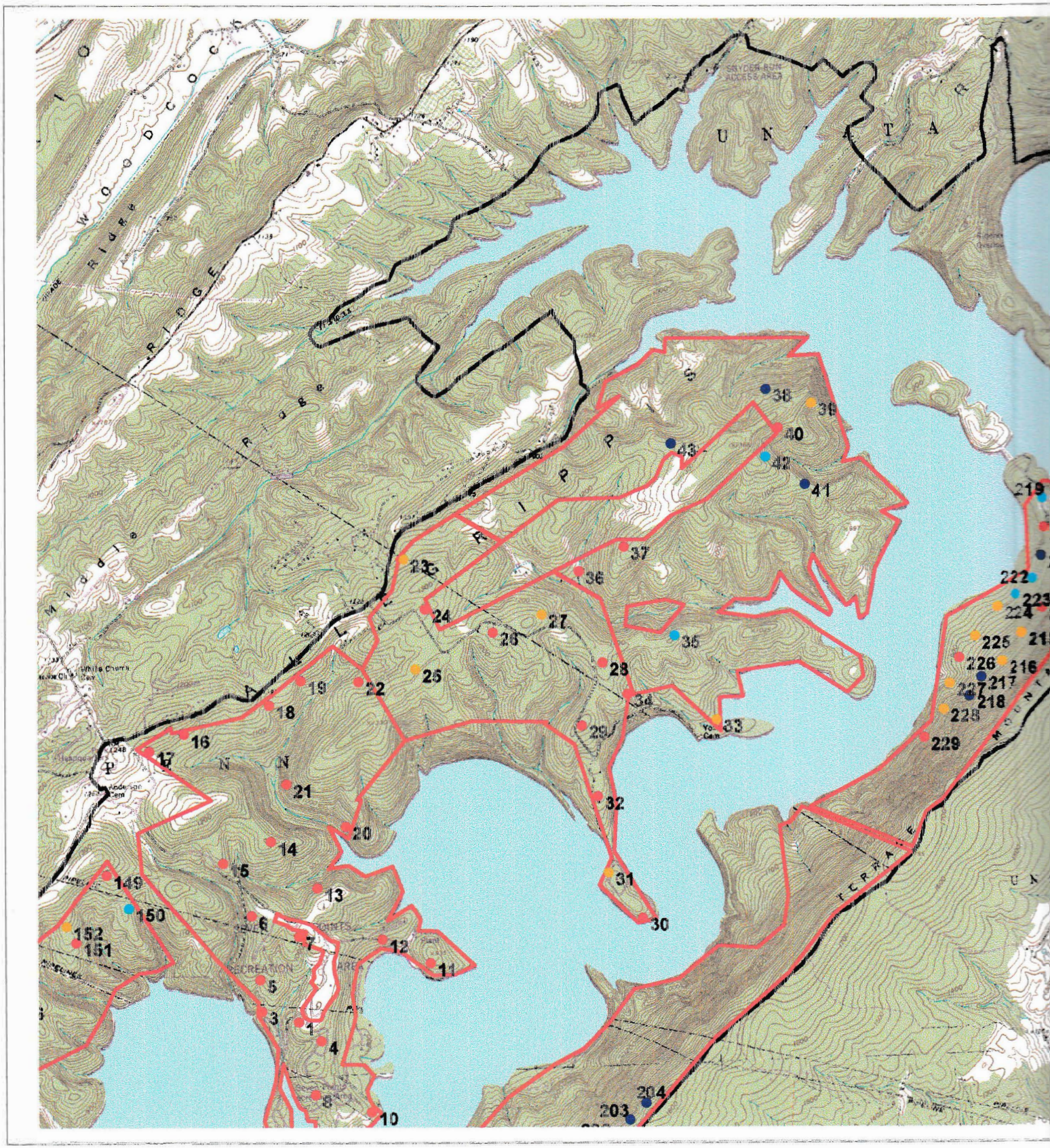
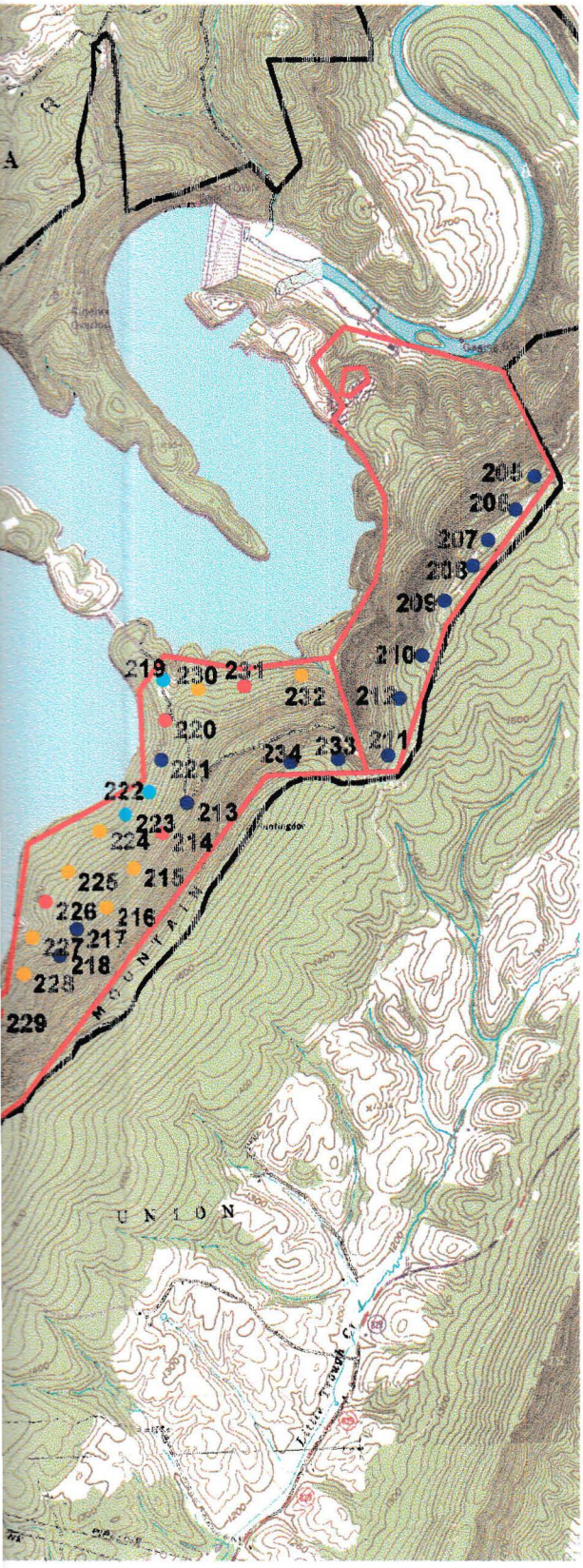


Figure 2a. -- Gypsy moth survey plot locations at Raystown Lake, September 25 -



mber 25 - December 11, 2000.




## Egg Mass Survey Points

- 0 - 249 em/acre
- 250 - 749 em/acre
- 750 - 1999 em/acre
- 2000 + em/acre
- Property Boundary
- Proposed Treatment Blocks

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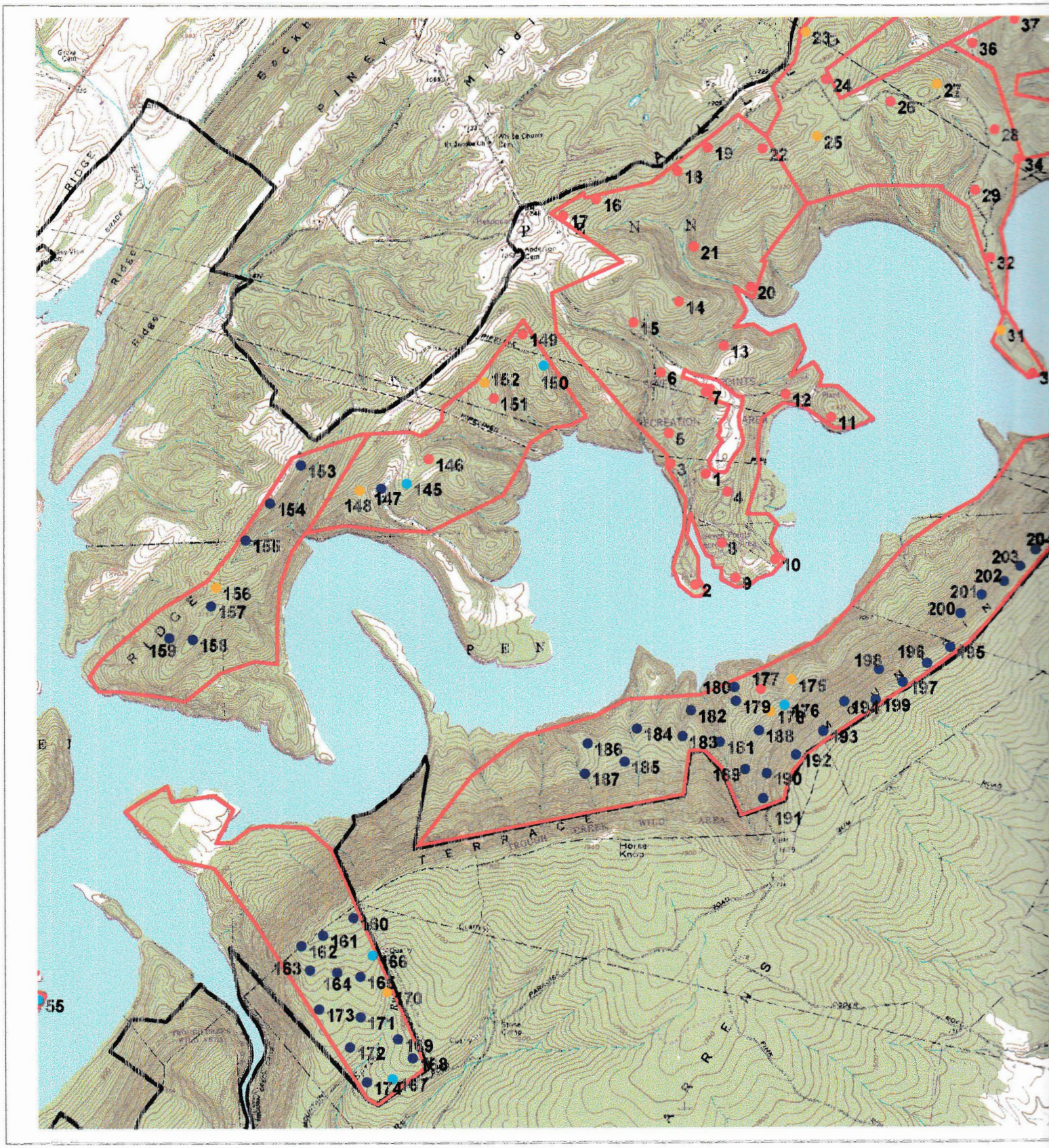
Figure 2b. -- Gypsy moth survey plot locations at Raystown Lake, September 25 -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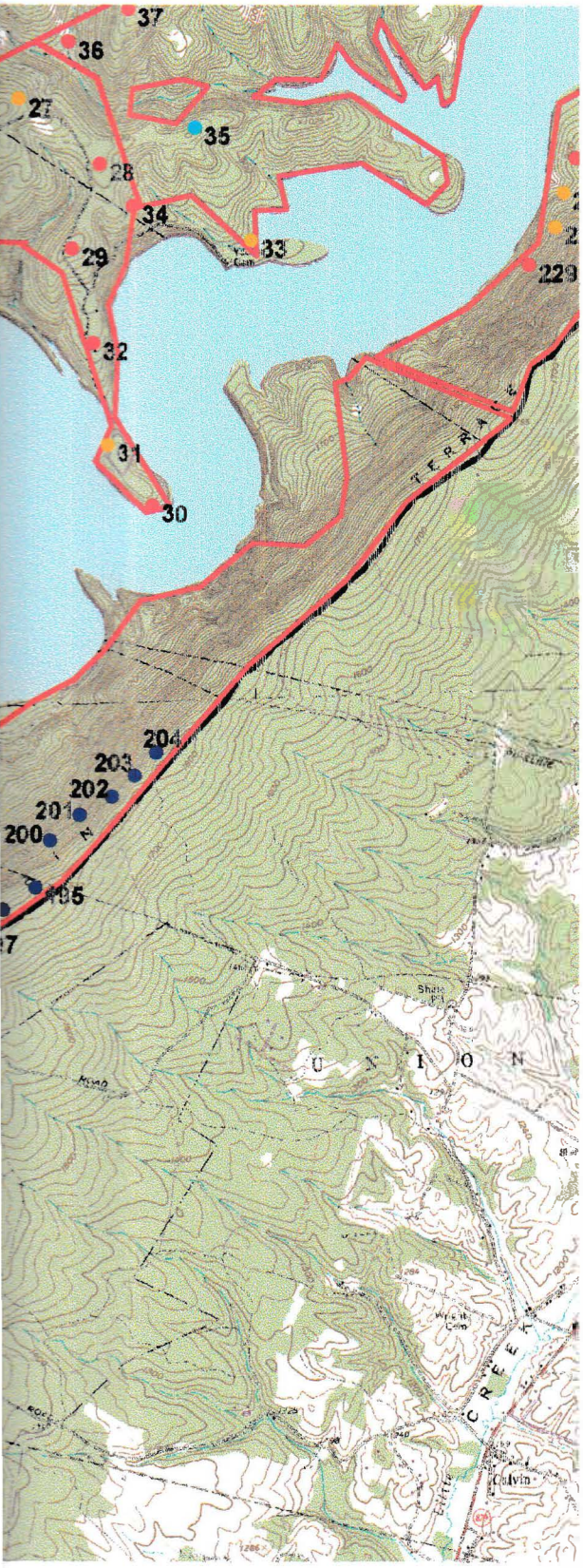


## Egg Mass Survey Points

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- Property Boundary
- Proposed Treatment Blocks

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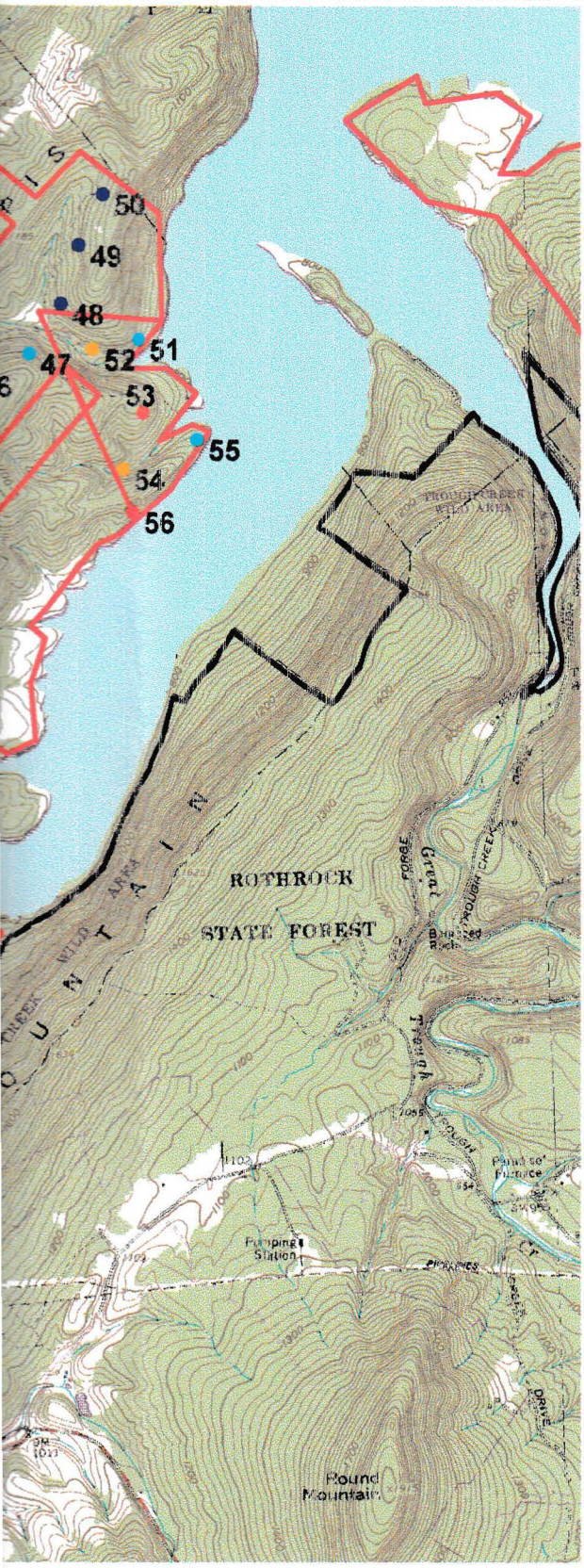
Figure 2c. -- Gypsy moth survey plot locations at Raystown Lake, September 25 -

mber 25 - December 11, 2000.




Egg Mass Survey Points

- 0 - 249 em/acre
- 250 - 749 em/acre
- 750 - 1999 em/acre
- 2000 + em/acre

Property Boundary

Proposed Treatment Blocks

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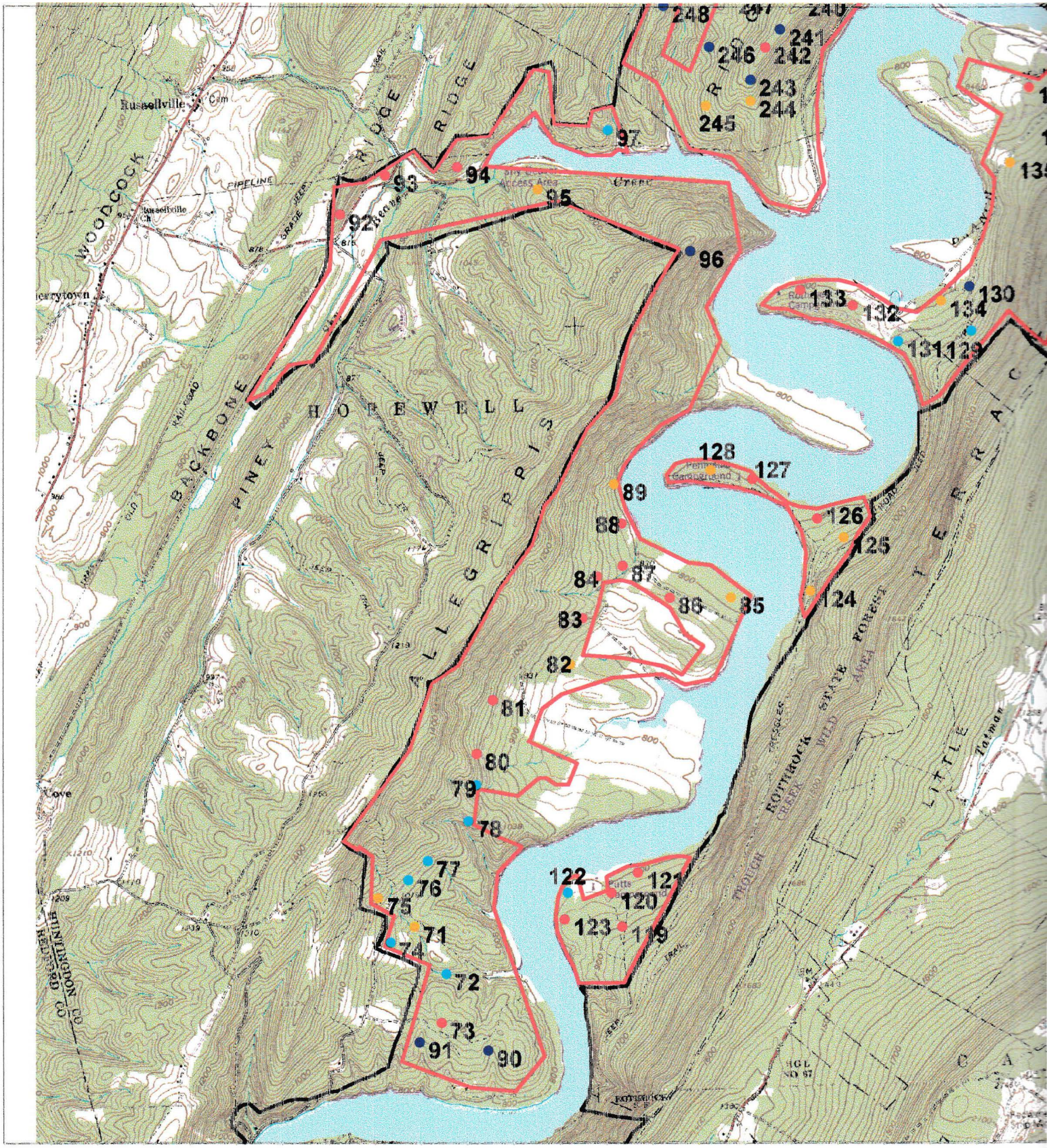
Figure 2d. -- Gypsy moth survey plot locations at Raystown Lake, September 25 -



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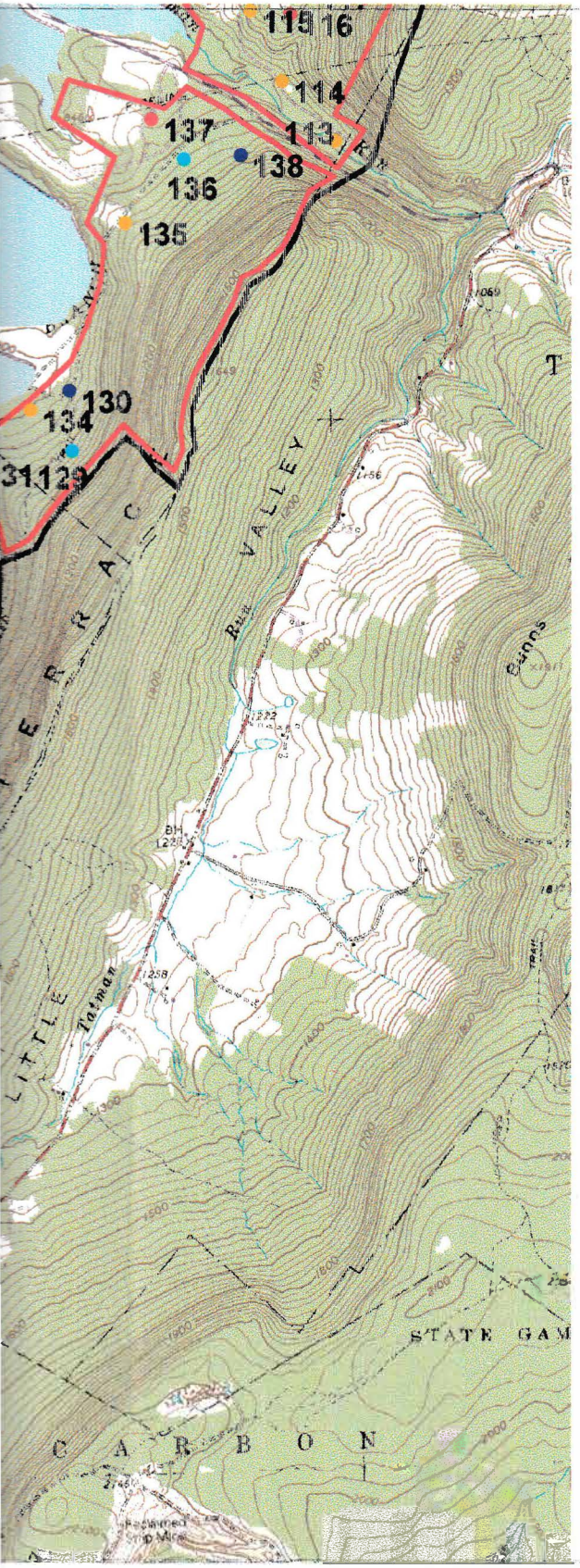


Egg Mass Survey Points

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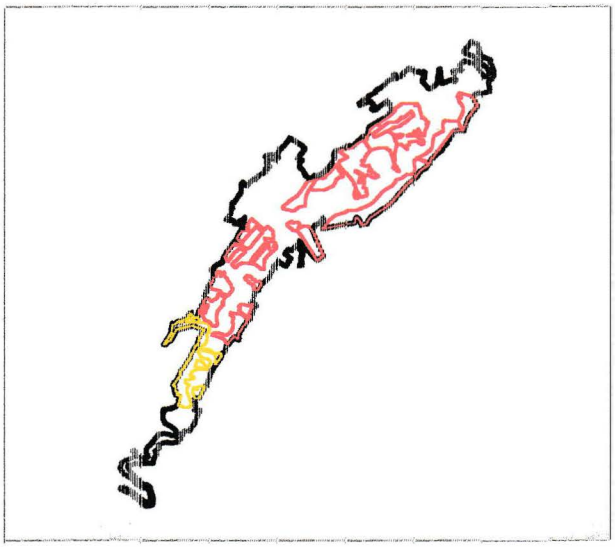

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Table 1 – Gypsy moth egg mass survey results at Raystown Lake (Susquehannock/Seven Points), September 25-28, 2000.

| Plot Number | Number EM/Acre | Plot Number | Number EM/Acre |
|---|---|---|---|
| 1 | 11,200 | 23 | 1,600 |
| 2 | 21,200 | 24 | 3,080 |
| 3 | 3,200 | 25 | 1,080 |
| 4 | 15,640 | 26 | 3,160 |
| 5 | 5,720 | 27 | 1,160 |
| 6 | 5,960 | 28 | 2,960 |
| 7 | 9,240 | 29 | 4,080 |
| 8 | 15,960 | 30 | 5,800 |
| 9 | 3,080 | 31 | 1,920 |
| 10 | 9,520 | 32 | 2,440 |
| 11 | 10,120 | 33 | 1,640 |
| 12 | 9,440 | 34 | 2,920 |
| 13 | 10,040 | 35 | 320 |
| 14 | 6,960 | 36 | 5,040 |
| 15 | 31,200 | 37 | 2,000 |
| 16 | 9,200 | 38 | 0 |
| 17 | 4,080 | 39 | 1,800 |
| 18 | 9,440 | 40 | 2,840 |
| 19 | 4,280 | 41 | 40 |
| 20 | 7,320 | 42 | 400 |
| 21 | 5,760 | 43 | 240 |
| 22 | 2,360 | | |
| EM/acre range = 0-31,200 | | EM/acre average = 5,941 | |
| EM size range (mm) = 19-35 | | EM size average (mm) = 29 | |

Table 2 – Gypsy moth egg mass survey results at Raystown Lake (Nancy's Camp), September 27, 2000.

| Plot Number | Number EM/acre | Plot Number | Number EM/acre |
|---|---|---|---|
| 44 | 3,280 | 58 | 120 |
| 45 | 200 | 59 | 120 |
| 46 | 80 | 60 | 0 |
| 47 | 480 | 61 | 520 |
| 48 | 200 | 62 | 80 |
| 49 | 0 | 63 | 200 |
| 50 | 40 | 64 | 640 |
| 51* | 360 | 65 | 0 |
| 52* | 1,080 | 66 | 0 |
| 53* | 2,280 | 67 | 360 |
| 54* | 1,120 | 68 | 40 |
| 55* | 440 | 69 | 80 |
| 56* | 4,240 | 70 | 1,080 |
| 57 | 320 | | |

EM/acre range = 0-4,240
EM/acre average = 643
EM size range (mm) = 14-30
EM size average (mm) = 20

EM/acre range is revised treatment block = 360-4,240
EM/acre average in revised treatment block = 1,587
* denotes plot is located in revised treatment block

Table 3 – Gypsy moth egg mass survey results at Raystown Lake (Gate 35/Shy Beaver), September 27 and 28, 2000.

| Plot Number | Number EM/acre | Plot Number | Number EM/acre |
|---|---|---|---|
| 71 | 880 | 85 | 1,520 |
| 72 | 680 | 86 | 7,560 |
| 73 | 2,160 | 87 | 2,040 |
| 74 | 400 | 88 | 6,440 |
| 75 | 1,640 | 89 | 760 |
| 76 | 480 | 90 | 80 |
| 77 | 360 | 91 | 200 |
| 78 | 520 | 92 | 3,120 |
| 79 | 520 | 93 | 3,720 |
| 80 | 2,120 | 94 | 6,400 |
| 81 | 5,120 | 95 | 1,840 |
| 82 | 1,200 | 96 | 200 |
| 83 | 2,520 | 97 | 640 |
| 84 | 3,120 | | |
| EM/acre range = 80-7,560 | | EM size range (mm) = 18-42 | |
| EM/acre average = 2,083 | | EM size average (mm) = 30 | |

Table 4 – Gypsy moth egg mass survey results at Raystown Lake (Clapper's Ridge North), September 28, 2000.

| Plot Number | Number EM/acre | Plot Number | Number EM/acre |
|---|---|---|---|
| 98 | 1,560 | 106 | 160 |
| 99 | 0 | 107 | 1,080 |
| 100 | 80 | 108 | 920 |
| 101 | 4,760 | 109 | 720 |
| 102 | 1,200 | 110 | 2,040 |
| 103 | 280 | 111 | 40 |
| 104 | 1,080 | 112 | 1,440 |
| 108 | 1,000 | | |
| EM/acre range = 0- 4,760 | | EM size range (mm) = 16-34 | |
| EM/acre average = 1,091 | | EM size average (mm) = 22 | |

Table 5 – Gypsy moth egg mass survey results at Raystown Lake (Tatman Run), September 28, 2000.

| Plot Number | Number EM/acre | Plot Number | Number EM/acre |
|---|---|---|---|
| 113 | 1,160 | 116 | 2,200 |
| 114 | 1,480 | 117 | 1,360 |
| 115 | 1,080 | 118 | 920 |
| EM/acre range = 920-2200 | | EM size range (mm) = 16-34 | |
| EM/acre average = 1,367 | | EM size average (mm) = 24 | |

Table 6 – Gypsy moth egg mass survey results at Raystown Lake (Putts Camp), November 6, 2000.

| Plot Number | Number EM/acre | Plot Number | Number EM/acre |
|---|---|---|---|
| 119 | 2,160 | 122 | 280 |
| 120 | 13,560 | 123 | 2,640 |
| 121 | 3,760 | | |
| EM/acre range = 280-13,560 | | EM size range (mm) = 22-36 | |
| EM/acre average = 4,480 | | EM size average (mm) = 29 | |

Table 7 – Gypsy moth egg mass survey results at Raystown Lake (Peninsula Campground), November 6, 2000.

| Plot Number | Number EM/acre | Plot Number | Number EM/acre |
|---|---|---|---|
| 124 | 1,080 | 127 | 2,080 |
| 125 | 1,080 | 128 | 1,640 |
| 126 | 6,800 | | |
| EM/acre range = 1,080-6,800 | | EM size range (mm) = 24-36 | |
| EM/acre average = 2,536 | | EM size average (mm) = 29 | |

Table 8 – Gypsy moth egg mass survey results at Raystown Lake (Resort Area), November 6, 2000.

| Plot Number | Number EM/acre | Plot Number | Number EM/acre |
|---|---|---|---|
| 129 | 440 | 134 | 1560 |
| 130 | 200 | 135 | 1240 |
| 131 | 360 | 136 | 360 |
| 132 | 4840 | 137 | 5040 |
| 133 | 3360 | 138 | 0 |
| EM/acre range = 0- 5,040 | | EM size range (mm) = 16-32 | |
| EM/acre average = 1,740 | | EM size average (mm) = 22 | |

Table 9 – Gypsy moth egg mass survey results at Raystown Lake (Marker 18), November 7, 2000.

| Plot Number | Number EM/acre | Plot Number | Number EM/acre |
|---|---|---|---|
| 139 | 120 | 142 | 400 |
| 140 | 80 | 143 | 2,560 |
| 141 | 720 | 144 | 1,880 |

EM/acre range 80-2,560
EM/acre average = 960
EM size range (mm) = 16-32
EM size average (mm) = 24

Table 10 – Gypsy moth egg mass survey results at Raystown Lake (Upper Corners), November 7, 2000.

| Plot Number | Number EM/acre | Plot Number | Number EM/acre |
|---|---|---|---|
| 145* | 560 | 153 | 0 |
| 146* | 2,040 | 154 | 0 |
| 147* | 0 | 155 | 0 |
| 148* | 760 | 156 | 760 |
| 149* | 4,120 | 157 | 0 |
| 150* | 520 | 158 | 40 |
| 151* | 3,360 | 159 | 120 |
| 152* | 920 | | |

EM/acre range = 0-4,120
EM/acre average = 877
EM size range (mm) = 16-32
EM size average (mm) = 23

EM/acre range is revised treatment block = 0-4,120
EM/acre average in revised treatment block = 1,535
* denotes plot is located in revised treatment block

Table 11 – Gypsy moth egg mass survey results at Raystown Lake (Trough Creek), November 13, 2000.

| Plot Number | Number EM/acre | Plot Number | Number EM/acre |
|---|---|---|---|
| 160 | 0 | 168 | 0 |
| 161 | 0 | 169 | 0 |
| 162 | 0 | 170 | 1,760 |
| 163 | 0 | 171 | 0 |
| 164 | 0 | 172 | 0 |
| 165 | 0 | 173 | 0 |
| 166 | 400 | 174 | 0 |
| 167 | 320 | | |

EM/acre range = 0- 1,760
EM/acre average = 165
EM size range (mm) = 15-34
EM size average (mm) = 21

Table 12 – Gypsy moth egg mass survey results at Raystown Lake (Terrace Mountain South), November 14 and 15, 2000.

| Plot Number | Number EM/Acre | Plot Number | Number EM/Acre |
|---|---|---|---|
| 175 | 920 | 190 | 0 |
| 176 | 440 | 191 | 0 |
| 177 | 2,960 | 192 | 0 |
| 178 | 1,000 | 193 | 0 |
| 179 | 0 | 194 | 0 |
| 180 | 0 | 195 | 0 |
| 181 | 0 | 196 | 0 |
| 182 | 0 | 197 | 0 |
| 183 | 0 | 198 | 0 |
| 184 | 0 | 200 | 0 |
| 185 | 0 | 201 | 0 |
| 186 | 0 | 202 | 0 |
| 187 | 0 | 203 | 0 |
| 188 | 0 | 204 | 0 |
| 189 | 0 | | |
| EM/acre range = 0-2,960<br>EM/acre average = 177 | | EM size range (mm) = 10-40<br>EM size average (mm) = 24 | |

Table 13 – Gypsy moth egg mass survey results at Raystown Lake (Terrace Mountain/Dam), November 15 and 16, 2000.

| Plot Number | Number EM/Acre | Plot Number | Number EM/Acre |
|---|---|---|---|
| 205 | 0 | 220* | 2280 |
| 206 | 0 | 221* | 0 |
| 207 | 0 | 222* | 600 |
| 208 | 0 | 223* | 720 |
| 209 | 0 | 224* | 1,000 |
| 210 | 0 | 225* | 1,080 |
| 211 | 0 | 226* | 2,960 |
| 212 | 0 | 227* | 1,360 |
| 213* | 120 | 228* | 960 |
| 214* | 2,360 | 229* | 2,600 |
| 215* | 1,120 | 230* | 760 |
| 216* | 1,800 | 231* | 3,560 |
| 217* | 0 | 232* | 1,680 |
| 218* | 0 | 233* | 0 |
| 219* | 600 | 234* | 0 |

EM/acre range = 0-3560 EM size range (mm) = 15-40
EM/acre average = 885 EM size average (mm) = 23

EM/acre range is revised treatment block = 0-3,560
EM/acre average in revised treatment block = 1,207
* denotes plot is located in revised treatment block

Table 14 – Gypsy moth egg mass survey results at Raystown Lake (Clapper's Ridge South), December 11, 2000.

| Plot Number | Number EM/Acre | Plot Number | Number EM/Acre |
|---|---|---|---|
| 235 | 1,480 | 243 | 0 |
| 236 | 0 | 244 | 1,160 |
| 237 | 0 | 245 | 1,640 |
| 238 | 0 | 246 | 0 |
| 239 | 0 | 247 | 0 |
| 240 | 2,400 | 248 | 0 |
| 241 | 0 | 249 | 0 |
| 242 | 3,280 | | |

EM/acre range = 0-3,280 EM size range (mm) = 10-35
EM/acre average = 653 EM size average (mm) = 22

This conclusion is further supported when egg density is used as a means of predicting defoliation. Moore and Jones (1987) found that estimating the mean fecundity will increase the precision of gypsy moth density estimates and that a linear relationship exists between egg mass length and fecundity. Further work by Liebhold et al., (1993) demonstrates that the product of the mean egg mass length (mm) and egg mass density provides a more precise means of estimating population densities and predicting defoliation. Using Liebhold's model, Figure 3 shows how this information can be used to correlate the predicted defoliation of an area. Susquehannock/Seven Points data is used in this figure.

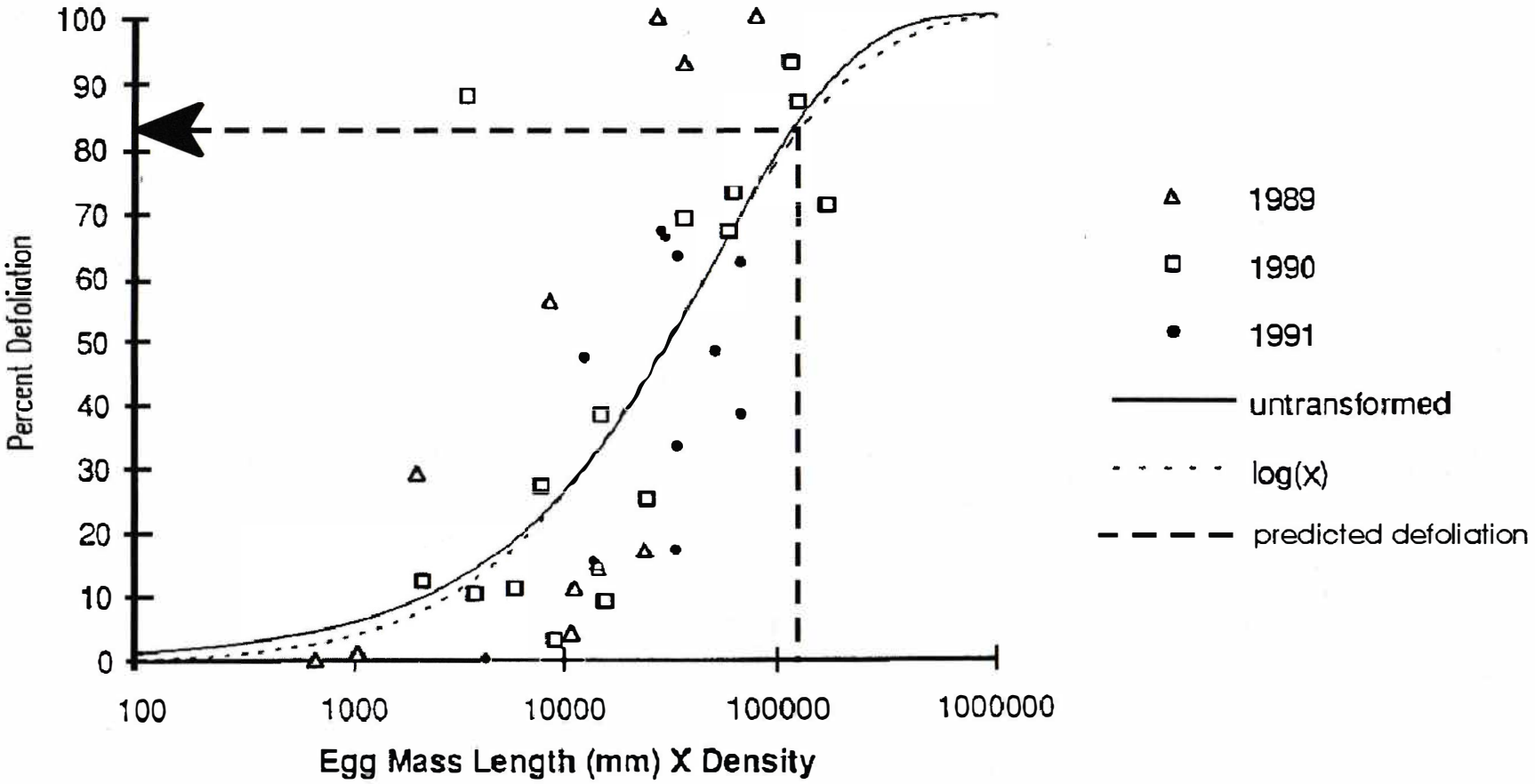
Accordingly, the estimated egg mass density of 5,941 egg masses per acre x 29 mm (average length of egg masses) at Susquehannock/Seven Points translates to a projected defoliation level of about 82 percent (heavy defoliation). Because egg mass densities and host type are not evenly distributed, actual defoliation will vary from tree to tree but will be predominately heavy throughout this proposed spray block. Table 15 shows the projected defoliation level in all the proposed treatment areas.

Based on existing egg mass densities and the general size of egg masses, gypsy moth populations appear to be building and healthy in some areas surveyed, (Susquehannock/Seven Points, Gate 35/Shy Beaver, Putts Camp, and Peninsula Campground) are static in some areas (Clapper's Ridge North, Tatman Run, Resort Area, Marker 18, the northern half of Upper Corners, the southern half of Terrace Mountain Dam and the immediate and area around Nancy's Campground) and are declining in the other areas. The overall average egg mass length is 25 mm. Egg masses longer than 25 mm typically indicate healthy populations with no obvious stress from either the gypsy moth nucleopolyhedrosis virus (NPV) or the *Entomophaga maimaiga* fungus, two of the primary natural control agents that often express themselves in declining or stressed populations. It is possible that either the gypsy moth fungus or the NPV could cause the collapse of defoliating levels of gypsy moth, however, it is unlikely that populations will collapse prior to a significant defoliation event occurring in 2001.

Predicting the extent of tree mortality that would occur after one year's defoliation is difficult, however, a stand of trees that is not stressed by other agents during or immediately following a single heavy defoliation will likely pull through with only minor branch dieback and minimal mortality. Trees that are defoliated in excess of 60 percent normally refoliate the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to deteriorate. Depending on the condition of the trees at the time of defoliation, reduced growth, mast abortion, branch dieback or in some cases tree mortality, has occurred following a single year of heavy defoliation. Should subsequent defoliation occur the following year, the impact is compounded. Trees that receive light-moderate defoliation (< 60 percent) are not likely to refoliate and there is probably no significant impact other than a reduction in growth, reduction of mast and possibly some minor branch dieback.

Trees at greater risk are those that are presently stressed from other factors, such as soil compaction from roads, sidewalks, parking lots, machinery and/or heavy foot travel; over maturity; drought; shock due to recent timber cutting activities; previous year(s) defoliation; and other insect and disease related problems. Droughty conditions have been experienced in this portion of Pennsylvania during the summer months in 1995, 1997, 1998 and 1999. However, adequate rainfall occurred during the growing season in 2000. Gypsy moth defoliation also occurred in 2000 at Raystown Lake. Approximately 25 acres of moderate defoliation and 5,249 acres of heavy defoliation were detected during the aerial survey on June 16 (Figure 4).

**Figure 3.--Predicted defoliation at Susquehannock/Seven Points based on egg mass length and density in 2001.**

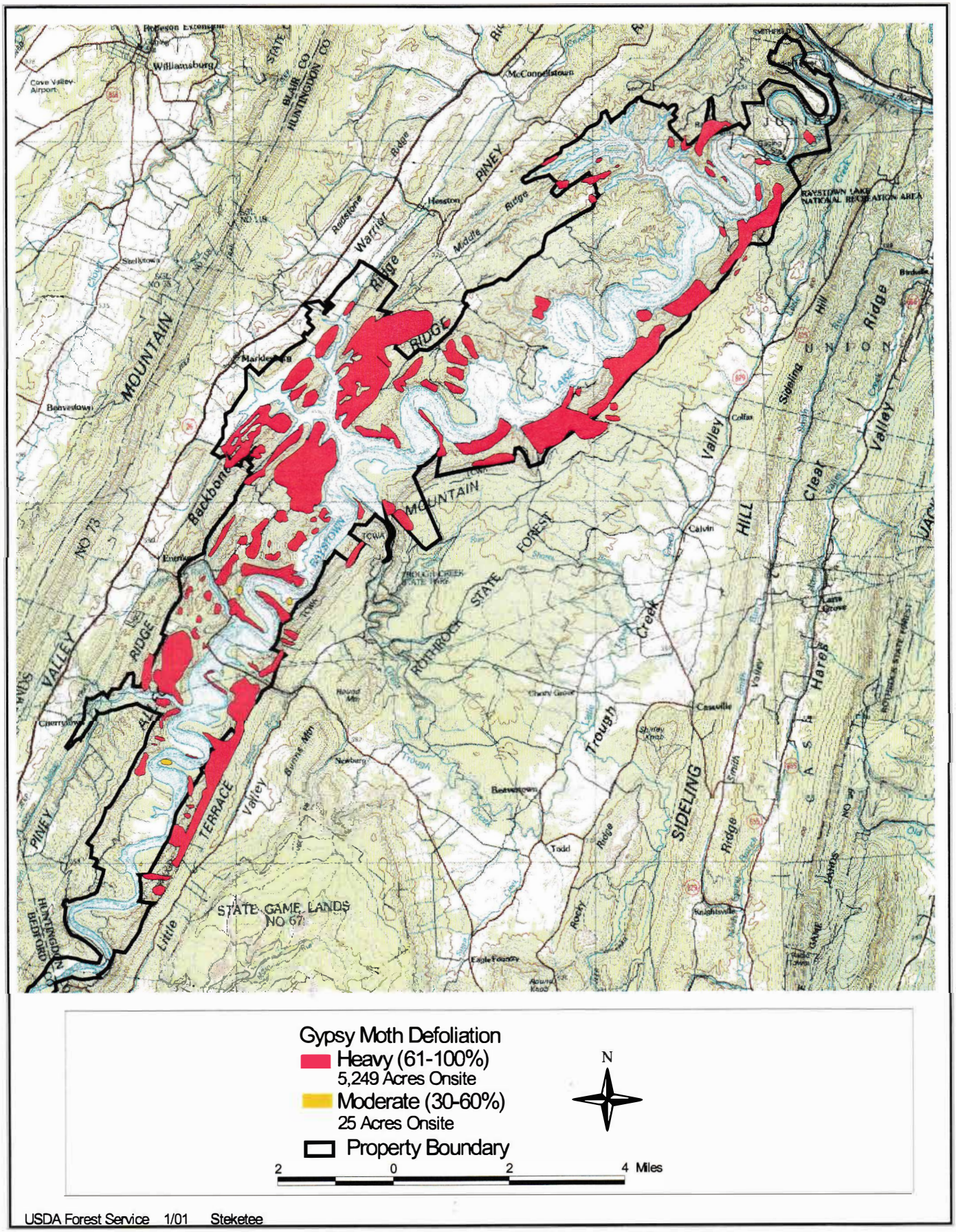



Scatter plot of the product of mean egg mass length and egg mass density versus mean defoliation. Extracted from Liebhold et al. (1993).

Table 15 – Projected defoliation levels by area at Raystown Lake in 2001.

| Area | Projected Defoliation | |
|---|---|---|
| | Percent Defoliation | Defoliation Class |
| Susquehannock/Seven Points | 82% | Heavy |
| Gate 35/Shy Beaver | 61% | Heavy |
| Putts Camp | 80% | Heavy |
| Peninsula Campground | 62% | Heavy |
| Clapper's Ridge North | 32% | Moderate |
| Tatman Run | 36% | Moderate |
| Resort Area | 39% | Moderate |
| Marker 18 | 33% | Moderate |
| Upper Corners (northern half) | 37% | Moderate |
| Nancy's Campground (immediate area) | 36% | Moderate |
| Nancy's Campground (remaining area) | 20% | Light |
| Upper Corners (southern half) | 20% | Light |
| Trough Creek | 10% | Light |
| Terrace Mountain South | 10% | Light |
| Terrace Mountain/Dam (southern half) | 32% | Moderate |
| Terrace Mountain/Dam (northern half) | 0% | N/A |
| Clappers Ridge South | 27% | Light |

Figure 4. -- Results of the gypsy moth defoliation survey conducted at Raystown Lake on June 16, 2000.



The Allegheny National Forest (1988) and the West Virginia Division of Forestry (1997) provide examples of the potential tree mortality that can occur. On the Allegheny National Forest, untreated stands consisting of 40-80 percent oak, the average loss of basal area (mainly oaks) was about 16 percent (range 3-28) percent) following one year of defoliation and 26 percent (range 10-43 percent) after two consecutive years of defoliation. In a 1986 study area in eastern West Virginia where oak species accounted for 63-78 percent of the species composition, a loss of 25 percent of the total oak sawtimber and 14 percent of the total oak poletimber occurred after one year of moderate to heavy defoliation. In these examples, droughty conditions likely contributed to the level of mortality. The adequate rainfall received during the 2000 growing season should significantly reduce the amount of mortality caused by the 2000 gypsy moth defoliation. Extensive mortality is likely, however should a severe defoliation event occur along with a dry growing season in 2001.

Regardless of tree mortality, gypsy moth defoliation has a significant impact on mast production. The potential loss of acorn mast was demonstrated by McConnell in 1988 (Gottschalk, 1990). His study found that moderate defoliation reduced production by about 50 percent and heavy defoliation near 100 percent. Other studies conducted by the Pennsylvania Game Commission had similar results and found that reduced acorn production continued for 1-2 years following the last year of defoliation.

## Management Options

For 2001, three management options have been evaluated for managing gypsy moth populations at Raystown Lake. The intervention options are offered based upon the following two treatment objectives: 1) protect host tree foliage to prevent mast failure and tree mortality; and 2) reduce gypsy moth population below the treatment threshold. Each is discussed below.

### No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of nucleopolyhedrosis virus (NPV) or the more recently recognized fungal pathogen, *Entomophaga maimaiga.* In areas with defoliating level gypsy moth populations (greater than 750 egg masses per acre) viral epizootics generally manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach defoliating levels and then collapse as a result of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels. Although it is not possible to accurately assess such events with the information at hand, it is unlikely that a collapse will occur prior to an extensive defoliation event in 2001.

Large numbers of gypsy moth caterpillars and defoliation has been shown to impact competing native herbivore arthropods. Sample et al. (1996) showed short-term impacts of both species richness and abundance occurred following light to moderate defoliation events in study plots in West Virginia. It is likely that impacts would be greater as the size of the area and intensity of defoliation increases and be more long term, should extensive tree mortality occur.

Should this option be selected, it is likely that widespread moderate and heavy defoliation will occur at Raystown Lake in 2001 and gypsy moth will spread into areas at Raystown Lake that are currently uninfested.

## Microbial Insecticide Option

***Btk*:** The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide *Bacillus thuringienis* variety *kurstaki (Btk)*. This insecticide is available through several manufacturers and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. *Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* is persistent on foliage for about 7-10 days.

*Btk* has been shown to impact other non-target caterpillars that are actively feeding at the time of treatment. An example of the potential impacts is provided by a study conducted by Miller (1990) in Oregon and Samples, et al. (1996) in West Virginia. Miller's study involved a large-scale (5,000 acres) eradication program where three consecutive applications of *Btk* were applied within a single season. On Garry oak, Miller found that species richness was significantly reduced in treated areas during all 3 years of the study while the total number of immature native Lepidoptera rebounded after the second year. In the Sample study, the areas treated with *Btk* were 50 acre plots and only a single treatment applied. Here too, both species richness and the total numbers of native macro-lepidopterous caterpillars and adults were reduced but only for less than 1-year. The difference in duration of the impacts between these studies is probably the result of the number of treatment applications applied and the size of the treatment area involved.

*Btk* formulations are available as flowable concentrates, wettable powders, and emulsifiable suspensions. The normal application rates range from 24-36 billion international units (BIUs) per acre in a single or double application. *Btk* can be applied either undiluted or mixed with water for a total volume of ½-1 gallon per acre. With proper application, foliage protection and some degree of population reduction can be expected with one application and with two applications both foliage protection and a greater degree of population reduction are likely. Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population (building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product.

**Gypchek:** A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3-5 days) as well as other biological factors such as feeding activity and weather conditions, it has been difficult at best to project treatment efficacy. Most often foliage protection can be achieved but significant reductions in

gypsy moth densities do not always occur. Should inadequate population reduction occur, areas would need to be treated again the following year.

The normal application rate of Gypchek is $2 \times 10^{11}$ occlusion bodies (OB's) per acre applied in two applications, 3-5 days apart. Due to the limited supply, priority is first given to state and federal cooperators that need to deal with federally listed threatened and endangered species associated with gypsy moth treatments.

## Chemical Insecticide Option

The third option is to use a chemical insecticide to control gypsy moth populations. There is currently only one chemical insecticide registered for control of gypsy moth populations and approved by the USDA Forest Service for use in cooperative gypsy moth control programs.

**Dimilin®** (diflubenzuron) is the most widely used chemical insecticide in gypsy moth suppression projects in the U.S. Diflubenzuron (DFB) is an insect growth regulator that disrupts the normal molting processes of the larvae. The mode of action is to inhibit the formation of chitin, a necessary component of the outer cuticle which causes the affected larvae to die during the molt following treatment. The method of uptake is primarily by ingestion, however, some research has indicated the possibility of absorption through the cuticle as well. DFB is relatively persistent on foliage (24 days) which increases the efficacy on gypsy moth populations but also exposes non-target insects, particularly caterpillars, for a greater period of time.

Dimilin® is registered by EPA for use in residential and forested areas. It is, however, extremely toxic to some aquatic invertebrates and the label prohibits the application over open water or wetlands. DFB is available as an oil based liquid formulation (Dimilin® 4L) and is normally applied in a single application at the standard rate of 1-2 ounces of formulated material per acre. With proper application, foliage protection and a significant population reduction can be expected. The need for treatment of residual populations the following year is normally not necessary.

## Alternatives

With the previously described options in mind, the following alternatives are offered.

| | |
|---|---|
| Alternative 1. | -No action |
| Alternative 2. | -One aerial application of *Btk* at the rate of 36 BIUs in a total mix of ¾ gallon per acre. |
| Alternative 3 | -Two aerial application of *Btk*, as in alternative 2, applied 4-7 days apart. |
| Alternative 4 | -Two aerial applications of Gypchek at the rate of $2 \times 10^{11}$ OB's in a total mix of 1 gallon per acre, applied 3-5 days apart. |
| Alternative 5 | -One aerial application of Dimilin® at the rate of 0.75 oz formulated material in a total mix of 1 gallon per acre. |

# RECOMMENDATIONS

As previously stated, gypsy moth populations at Raystown Lake are sufficient to cause widespread moderate and heavy defoliation in 2001. In order to protect tree foliage, mast production and prevent subsequent tree mortality, the recommendation is to implement Alternative 2 ( a single application of Btk) on 2,007 acres and Alternative 3 (a double application of Btk) on 4,140 acres (Figure 5). The single application of Btk is to be applied at Clapper's Ridge North, Tatman Run, Resort Area, Marker 18, the northern half of Upper Corners, the southern half of Terrace Mountain Dam, and the immediate area around Nancy's Campground. The double application of Btk is to be applied at Susquehannock/ Seven Points, Gate 35/Shy Beaver, Putts Camp and Peninsula Campground.

Only small and scattered areas of defoliation, if any, are expected elsewhere at Raystown Lake in 2001.

Alternative 2 on 2007 acres and Alternative 3 on 4,120 acres are recommended based on the following considerations.

1) The application of Dimilin® could affect aquatic invertebrate populations in many small streams within the treatment areas. All these streams flow directly into the lake.

2) Due to its persistence on the foliage, Dimilin® could affect the food source of the endangered Indiana bat (*Myotis sodalis*).

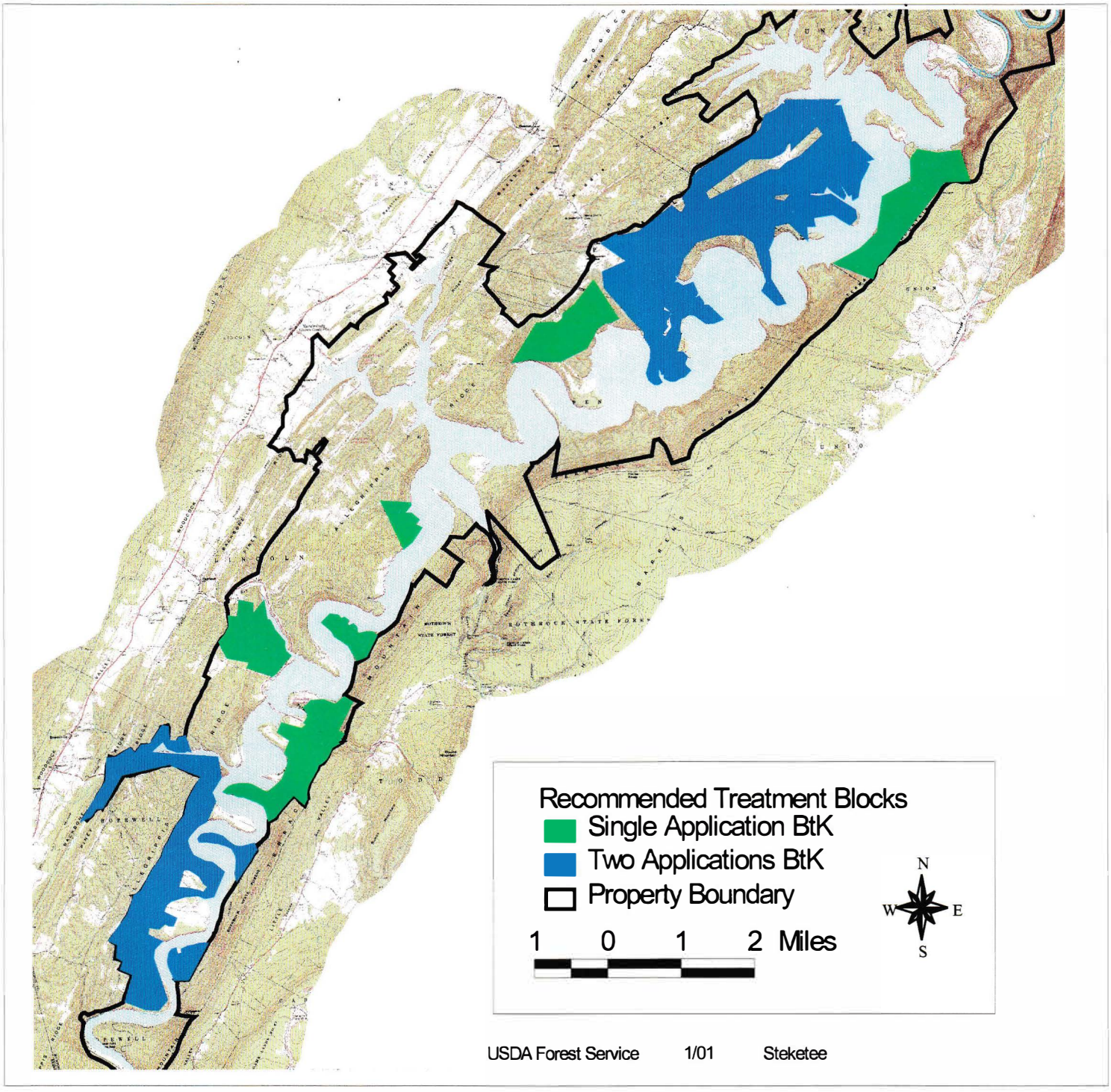
3) On the 2,007 acres, the health and the population densities of the gypsy moth do not warrant a double application of Btk. A single application of Btk will likely provide foliage protection and a population reduction.

4) On the 4,140 acres, gypsy moth densities are too high and the populations are too healthy for a single application of Btk. A double application of Btk is likely to provide both a population reduction and foliage protection.

5) A double application of Gypchek on all 6,147 acres is likely to provide some foliage protection but no significant reductions in population levels. Better results are much more likely with Btk.

6) The cost of a single application of Btk on 2,007 acres and a double application of Btk on 4,140 acres is more economical than a double application of Gypchek on all 6, 147 acres.

Figure 5. -- Recommended gypsy moth treatment blocks at Raystown Lake in 2001.



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2000

USDA United States Department of Agriculture | Forest Service | Northeastern Area State and Private Forestry | 180 Canfield Street Morgantown, WV 26505- 3101

File Code: 3400
Date: January 5, 2001

Mr. Greg Mollenkopf
U.S. Army Corps of Engineers
Attn: CENAB-OP-PN
Baltimore, MD 21203

Dear Mr. Mollenkopf:

Enclosed is the gypsy moth biological evaluation for Raystown Lake.

In brief, gypsy moth populations are sufficient to cause widespread defoliation at Raystown Lake. We are recommending a single application of *Bacillus thuringiensis* (*Btk*) on 2,007 acres and a double application of Btk on 4,140 acres. With proper application, gypsy moth defoliation should be minimal at Raystown Lake in 2001.

We look forward to working with the Raystown staff during the suppression project.

Please contact Rod or Brad at (304) 285-1541 if you have any questions concerning the gypsy moth biological evaluation.

Sincerely,

JOHN W. HAZEL
Field Representative
Forest Health Protection

Enclosure

Cc: Dwight Beal, Raystown Lake
Allen Gwinn, Raystown Lake
Larry Rhoads, PA BOF
Noel Schneeberger, AO

JWH/RLW/blm



Karen